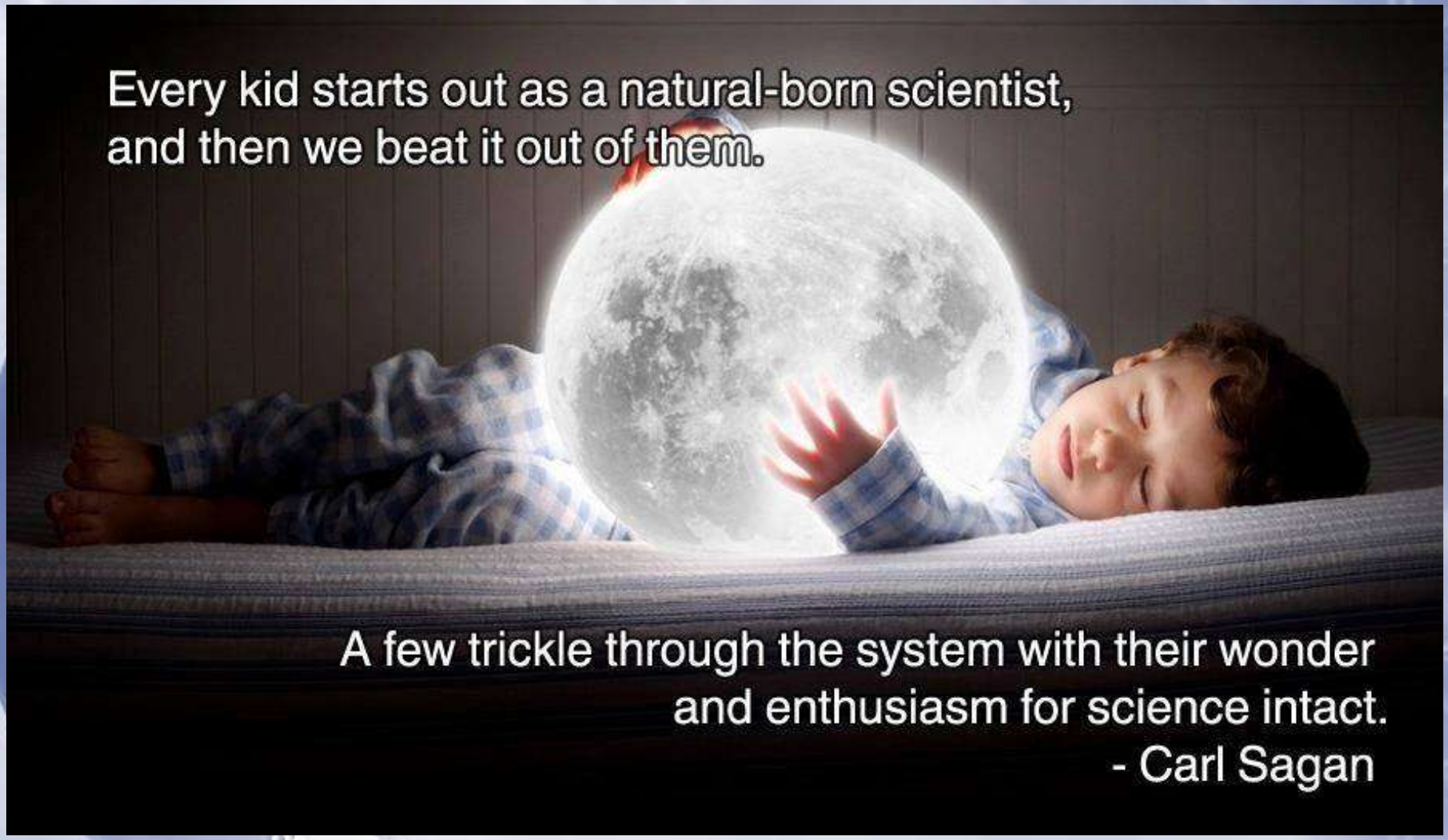
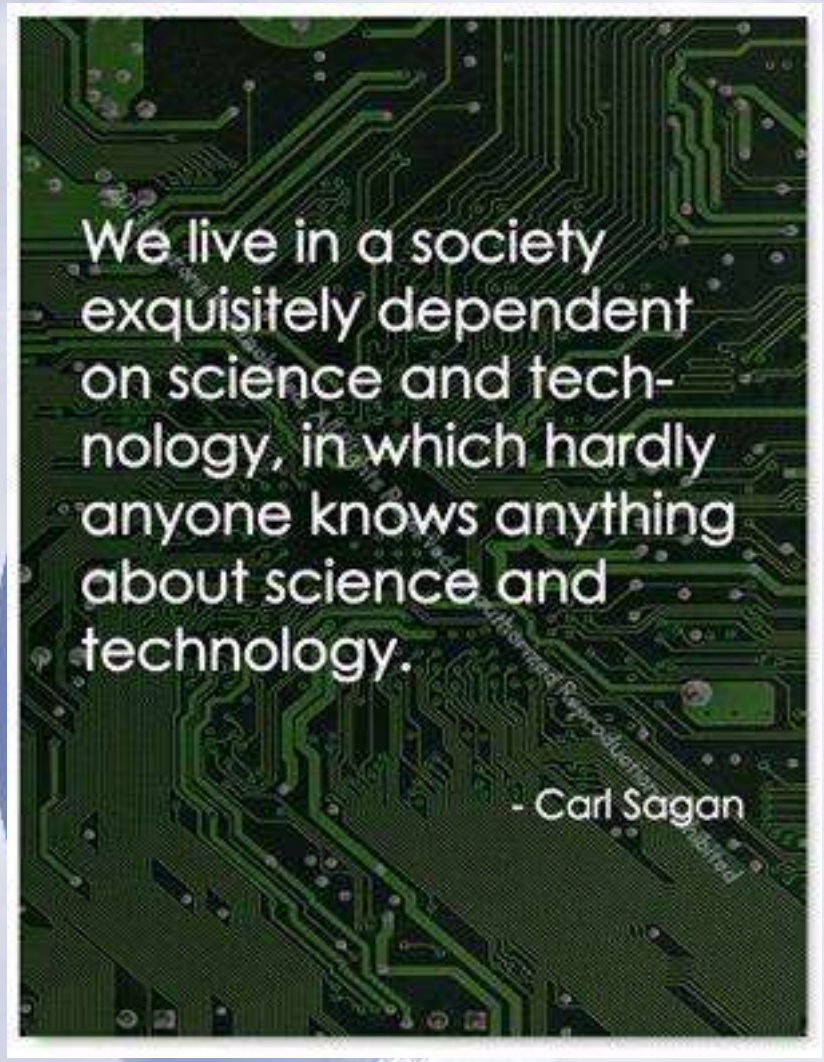
Climate Change: An Important Topic and a Tool for Teaching Science

Quarknet Teacher's Workshop
Aug. 1, 2014

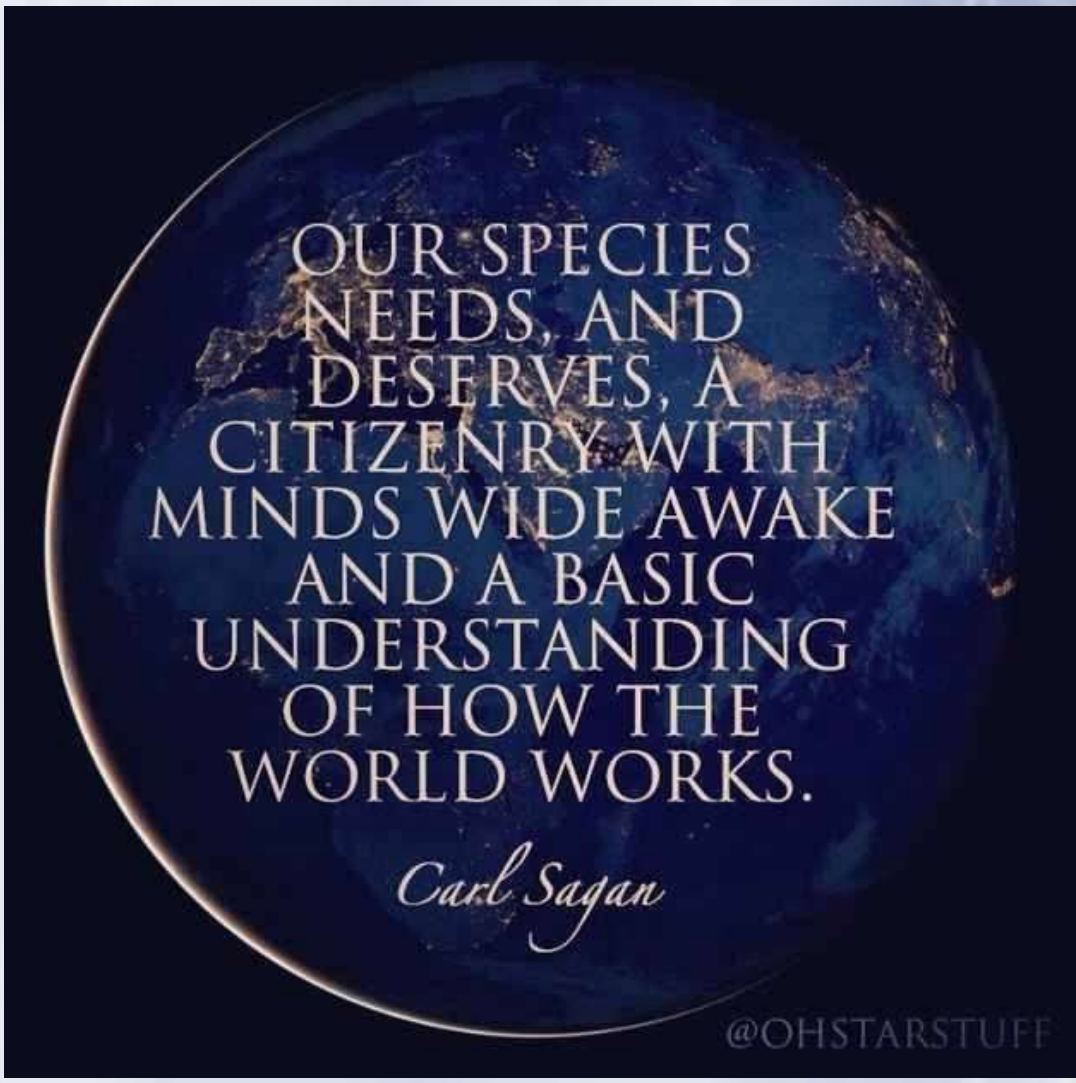
Dr. Bill Blair
Johns Hopkins University



We desperately need to increase the flow.



Quotes from 20+ years ago…more true today than ever!



"Science is not a subject you took in school. It's life. We are wrapped by it, in it, with it. And one's science literacy should never be viewed as a disposable dimension of one's mind -- not in this, the 21st century, where the engines of tomorrow's economies will derive from wise investments and innovations in science and technology."

NEIL DEGRASSE TYSON -

SPACE ADVOCATES

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Science and the Energy Sector

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Pure Lithium in Battery May Generate More Powerful Battery

Stanford researchers claim they have made a breakthrough in creating a lithium anode

ClimateWire

Jul 30, 2014 | By Henry Gass and ClimateWire

A team of Stanford University researchers, including former Energy Secretary Steven Chu, believes it has achieved the "holy grail" of lithium battery design: an anode of pure lithium that could boost the range of an electric car to 300 miles.

Lithium-ion batteries are one of the most common types of rechargeable batteries on the market today. But most of the batteries—found in technologies like smartphones and electric cars—use an anode made of graphite or silicon.

Lithium-ion batteries are one of the most common types of rechargeable batteries on the market today
Credit: pinkyracer via Flickr

The lithium in a lithium-ion battery today is found in the electrolyte. The electrons in the electrolyte flow to the anode during recharging, and if the anode were also made of lithium, the battery would be able to generate much more power and weigh much less.

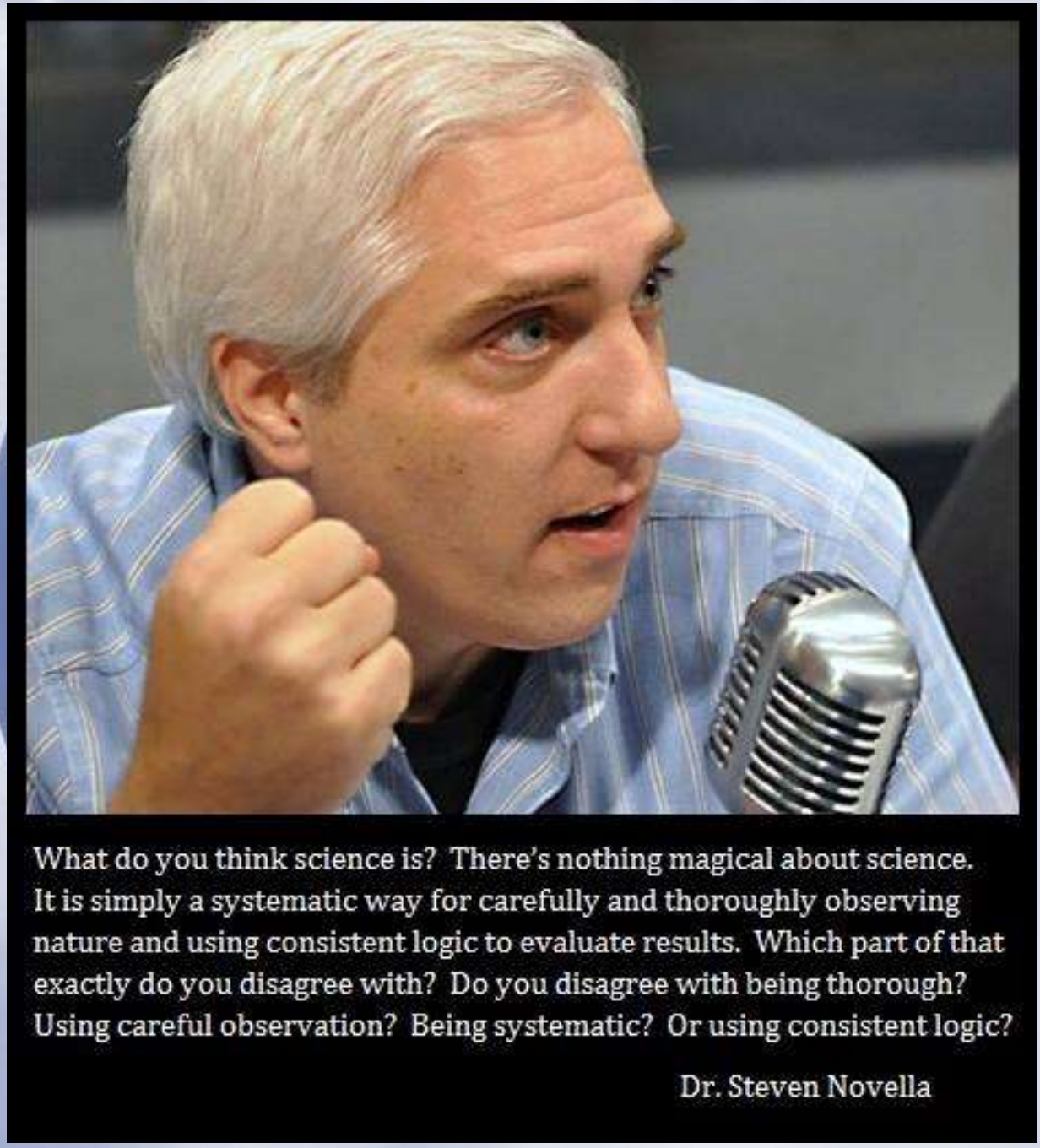
Until now, however, lithium anodes have been unusable. The material expands during charging, opening fissures on the surface that release lithium ions and form messy, hairlike growths called dendrites that reach out and short-circuit the battery. Lithium anodes are also highly chemically reactive with the lithium electrolyte and can overheat to the point of fire or even explosion.

The potential flammability of lithium-ion batteries has come under scrutiny after three electric cars made by Tesla Motors Inc. crashed and caught fire last year after hitting road debris (*Greenwire*, Nov. 8, 2013).

The Stanford team thinks it has solved these problems with a protective layer of tiny carbon domes, called nanospheres, that form a flexible honeycomb-styled shield over the anode. The nanosphere wall, just 20 nanometers thick, is strong and flexible enough to move up and down as the anode expands and contracts during the battery's charge-discharge cycle.

Chu, the former Energy secretary and a Nobel laureate, recently resumed his professorship at Stanford and is part of Cui's team. In a press release, he said the new lithium anode design could improve the battery's capacity fourfold.

"You might be able to have a cell phone with double or triple the battery life or an electric car with a range of 300 miles that cost only $25,000—competitive with an internal combustion engine getting 40 miles per gallon," Chu said.



When congressional science and technology committee members cannot understand basic logic, and deny the viability of science, it creates a dangerous situation.

That is certainly the case with climate change…

MAY 30, 2014

SCIENTISTS CONSIDER NEW NAMES FOR CLIMATE CHANGE

BY ANDY BOROWITZ

NEW HAVEN (The Borowitz Report)—After a report from the Yale Center on Climate Change Communication showed that the term "climate change" elicits relatively little concern from the American public, leading scientists are recommending replacing it with a new term: "You will be burnt to a crisp and die."

Other terms under consideration by the scientists include "your cities will be ravaged by tsunamis and floods" and "earth will be a fiery hellhole incapable of supporting human life."

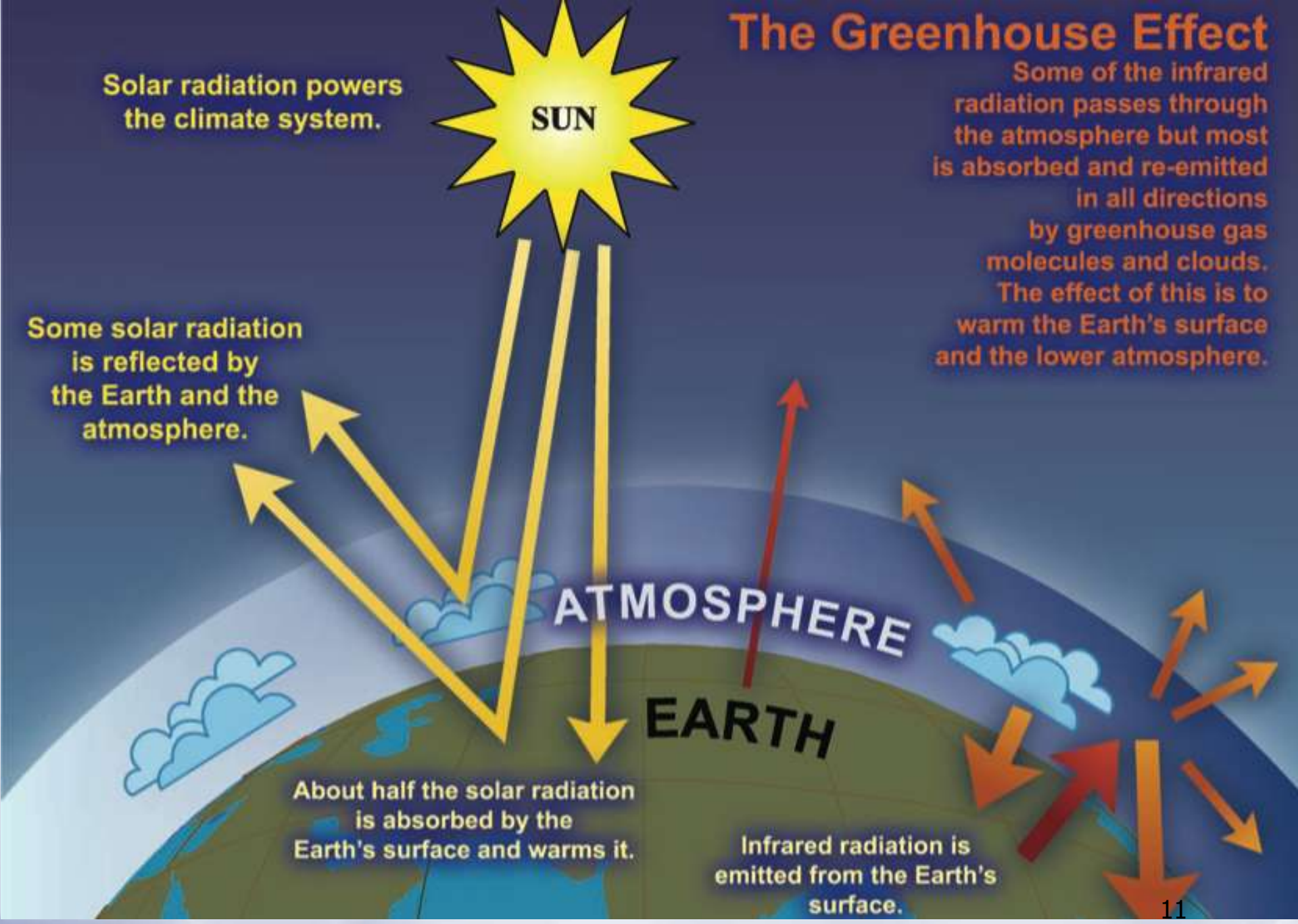
Climate Change -- Potential Confusion

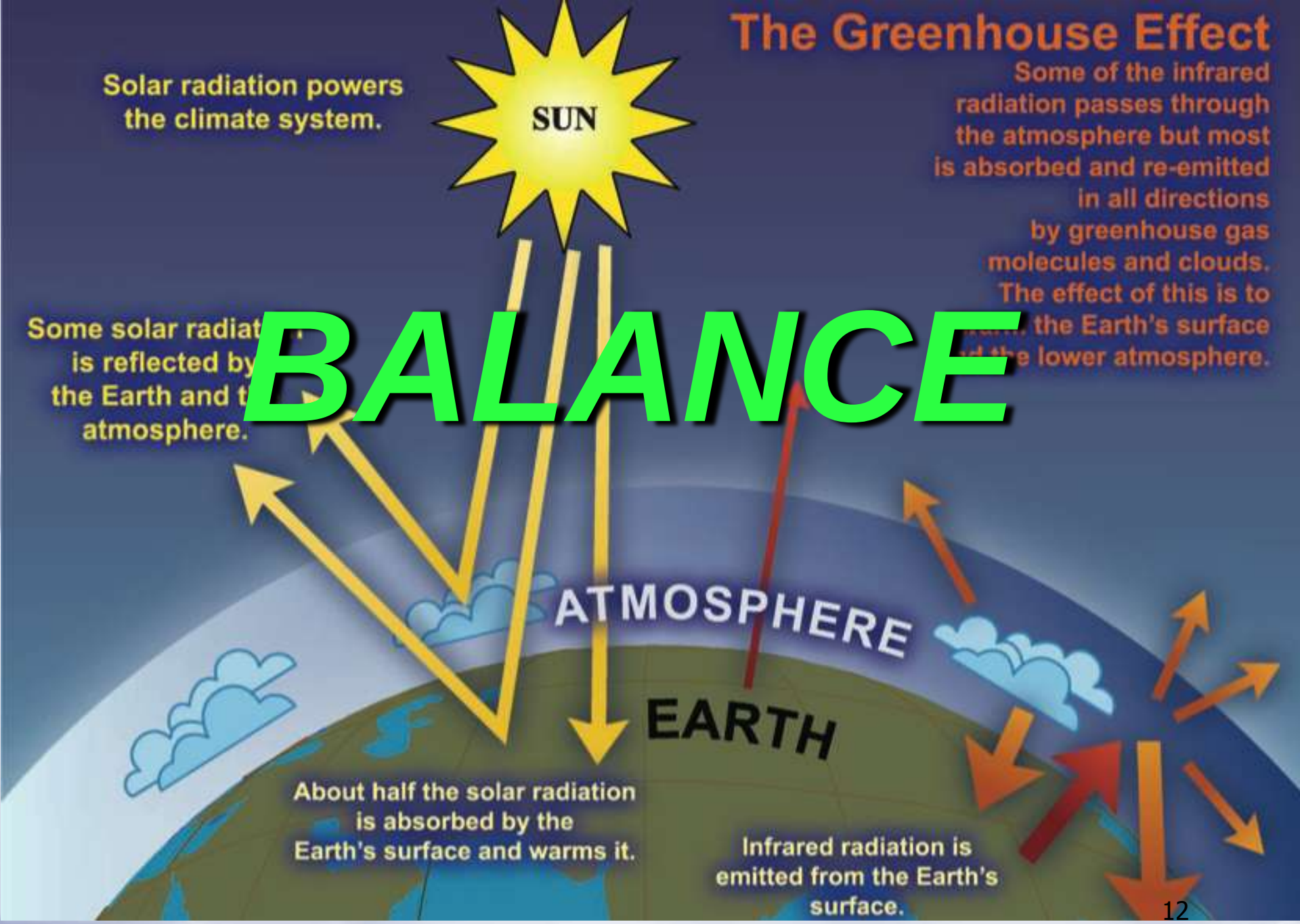
- "Not everybody agrees…" "Not all scientists agree…"
- "Isn't it just a natural variation?" "It's the sun."
- "What difference can a degree or two make?"
- "Are these funky local weather events due to GW?"
- "How can GW cause both droughts and floods?"
- "Climate models predict things all over the map. How can we believe anything from them?"
- Mercury in CFL bulbs-bad for the environment?
- Ethanol: not everything it's cracked up to be?
- Wind Energy: Environmental tug-of-war…
- Others?


Climate Change:
The Good, the Bad,
& the Ugly
Making climate change clear to
students and the general public

The Greenhouse Effect

- Sunlight comes through glass.
- Light is absorbed and re-radiated as heat (infrared light).
- Heat is trapped (warms interior of greenhouse).
- Need for “balance” to keep it from getting too hot/cold.


The Greenhouse Effect
Solar radiation powers the climate system.
SUN
Some of the infrared radiation passes through the atmosphere but most is absorbed and re-emitted in all directions by greenhouse gas molecules and clouds. The effect of this is to warm the Earth's surface and the lower atmosphere.
Some solar radiation is reflected by the Earth and the atmosphere.
ATMOSPHERE
EARTH
About half the solar radiation is absorbed by the Earth's surface and warms it.
Infrared radiation is emitted from the Earth's surface.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The Earth is so big…how can we affect things?


The Earth is so big…how can we affect things?
By affecting the
BALANCE

*Venus - Earth's "Twin"?**

- Closest planet to earth.
- Nearly the same size as earth, but
- CO_2 atmosphere 100x denser than earth's.
- Surface temp 900 degrees F.
- Example of "Runaway" Greenhouse effect.

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BALANCE

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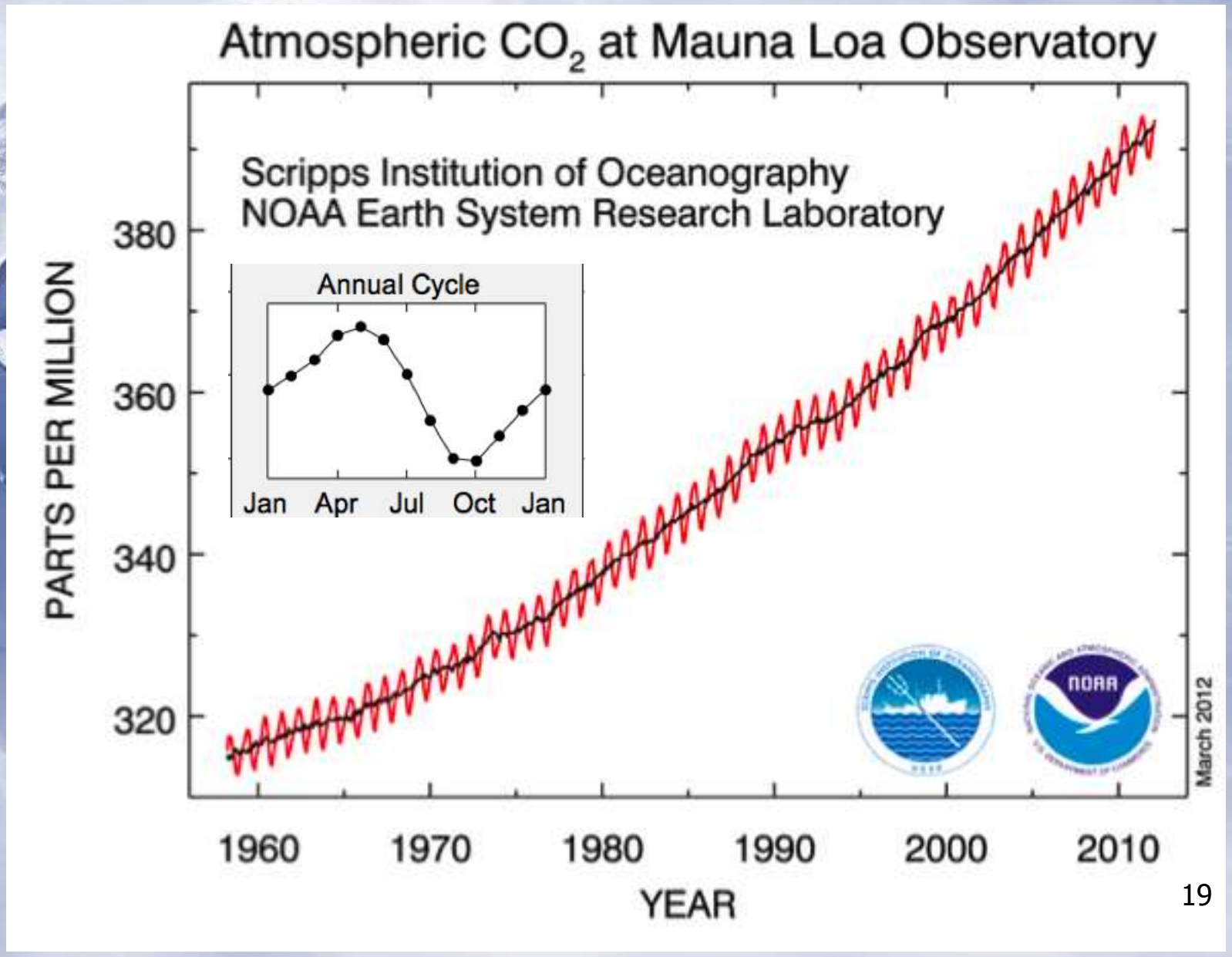
*(Let's hope not!)

Apollo 11, July 1969

Heat-trapping Gases

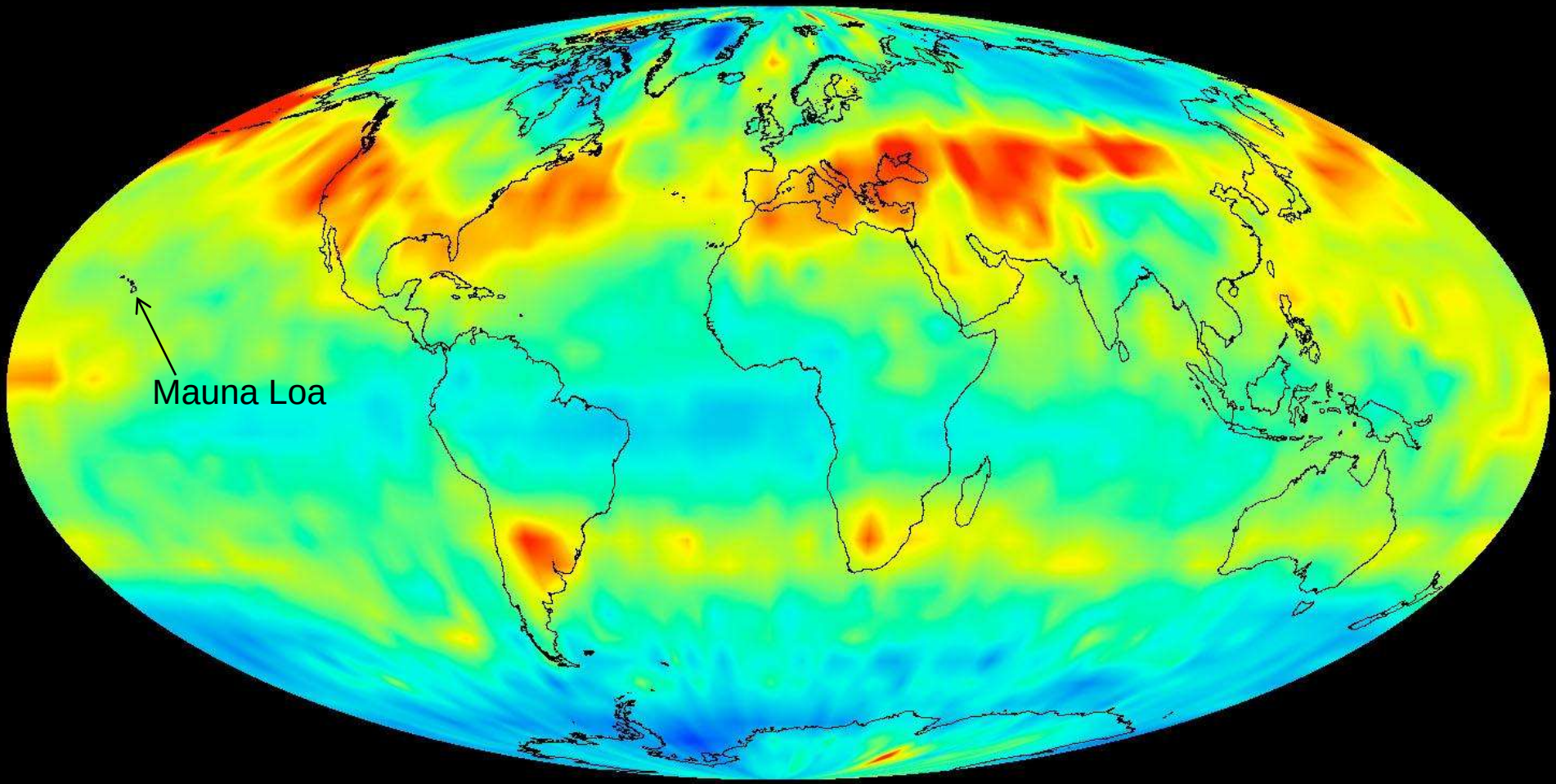
- Water Vapor H_2O
- Methane CH_4
- Carbon Dioxide CO_2
  - A trace constituent, but very effective at trapping heat.

Fact: Atmospheric CO_2 levels are increasing.



Carbon Dioxide in the Mid-Troposphere, July 2009

Data acquired by AIRS, the Atmospheric Infrared Sounder on NASA's Aqua Satellite

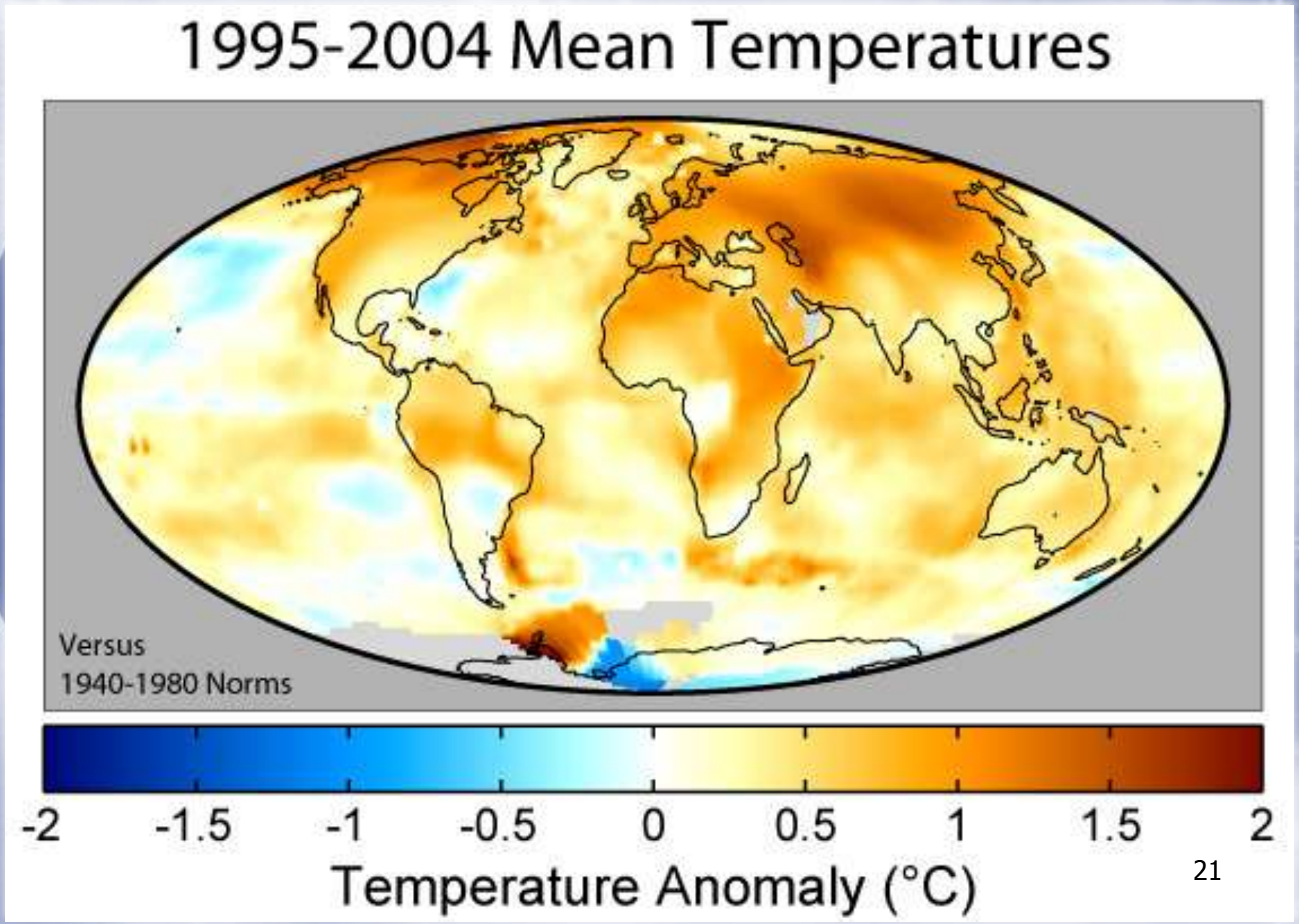


parts per million

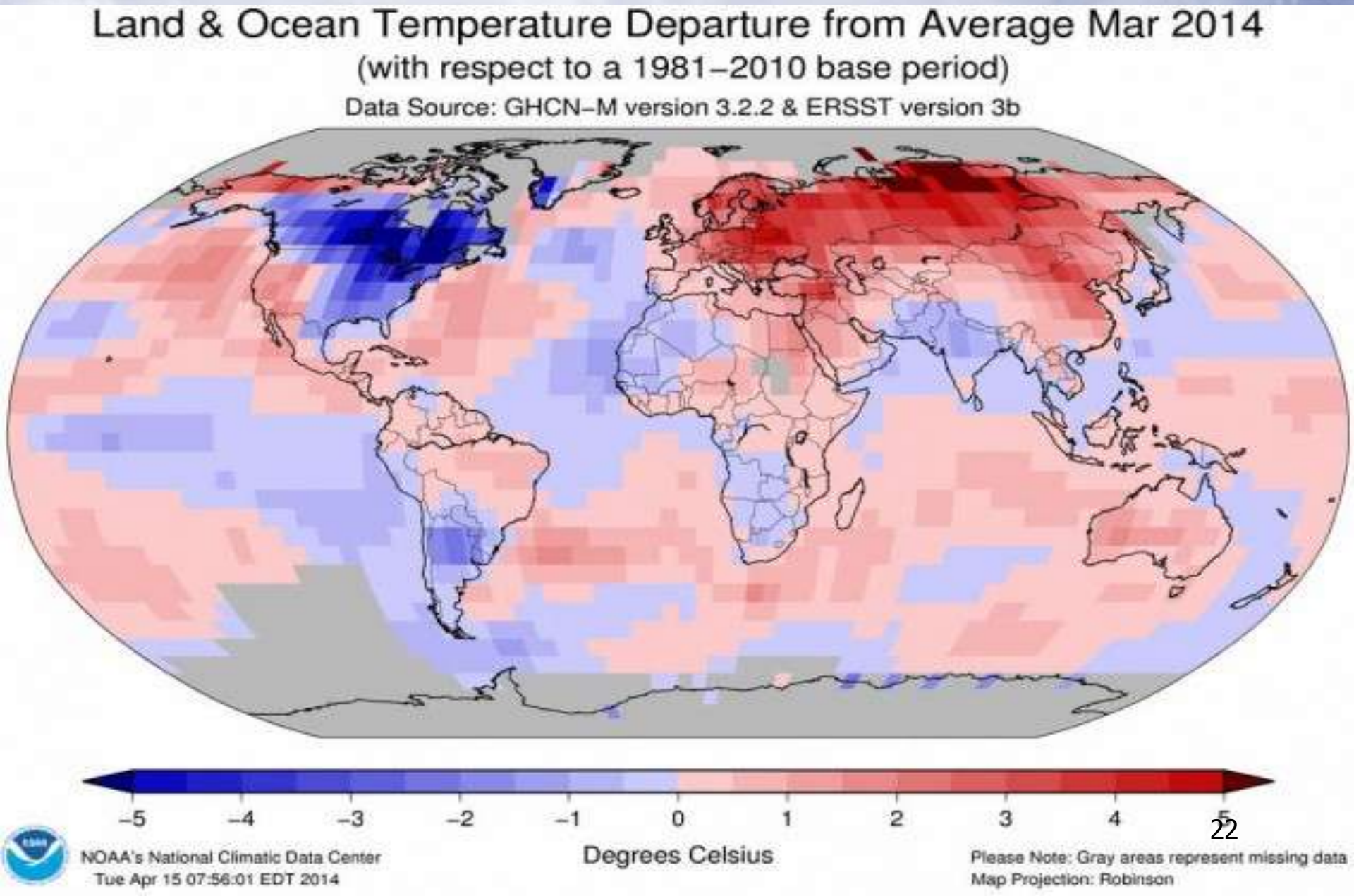
382 383 384 385 386 387 388 389

Monthly average atmospheric carbon dioxide concentration for July 2009 = 387 ppm. Measurement recorded at Mauna Loa Observatory (Scripps / NOAA / ESRL).

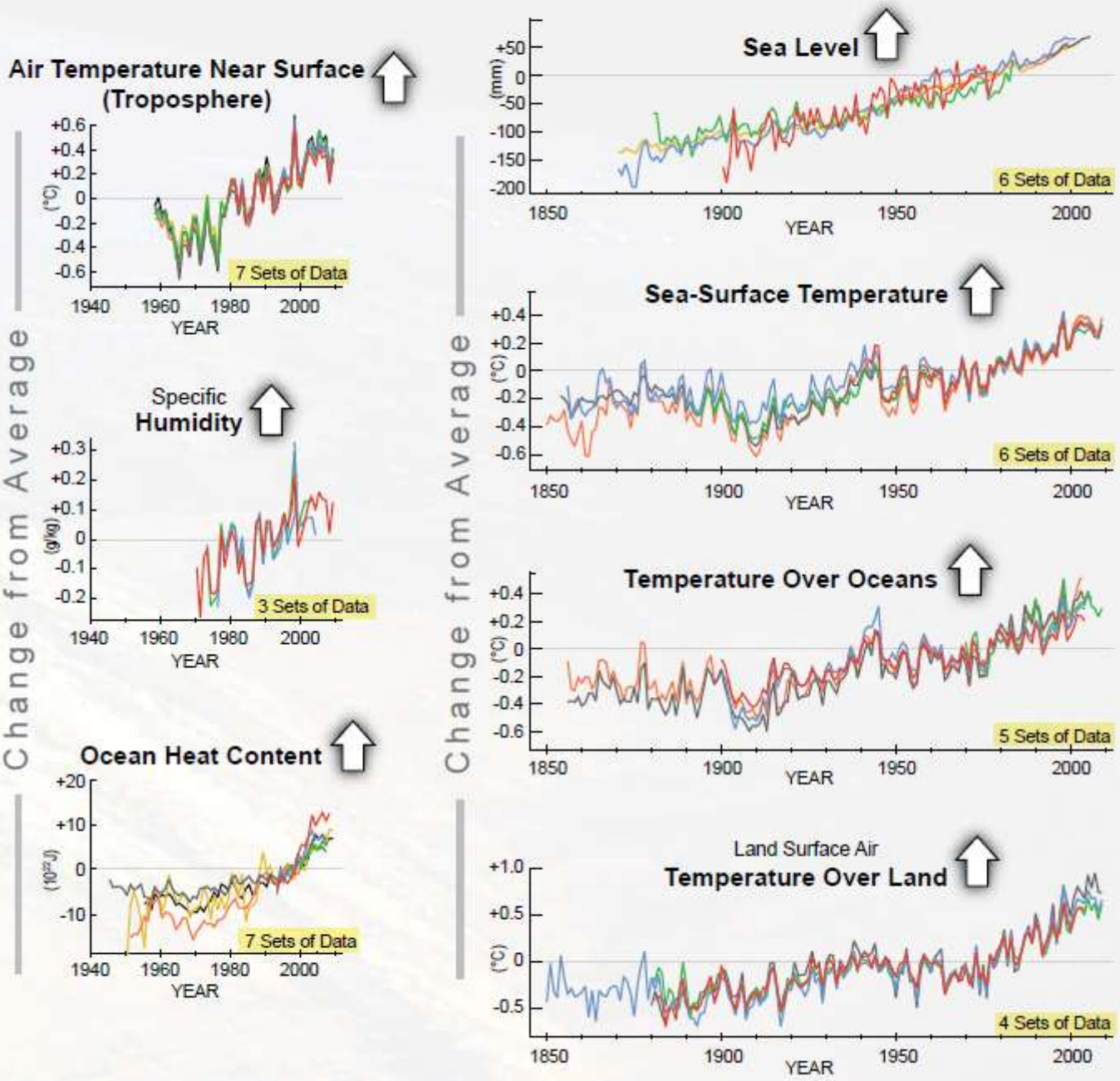
Fact: Globally-averaged Temperatures are increasing



Perspective on a Chilly Spring



These indicators all increase in a warming world



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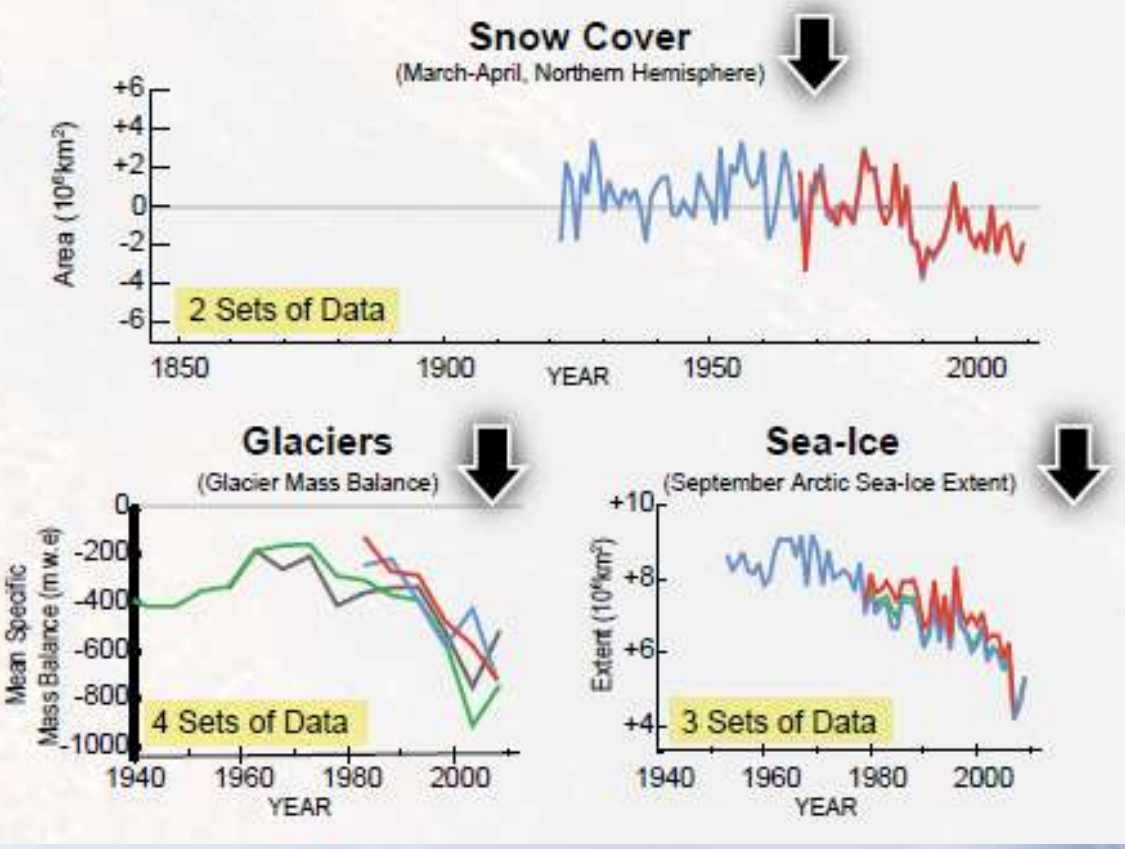
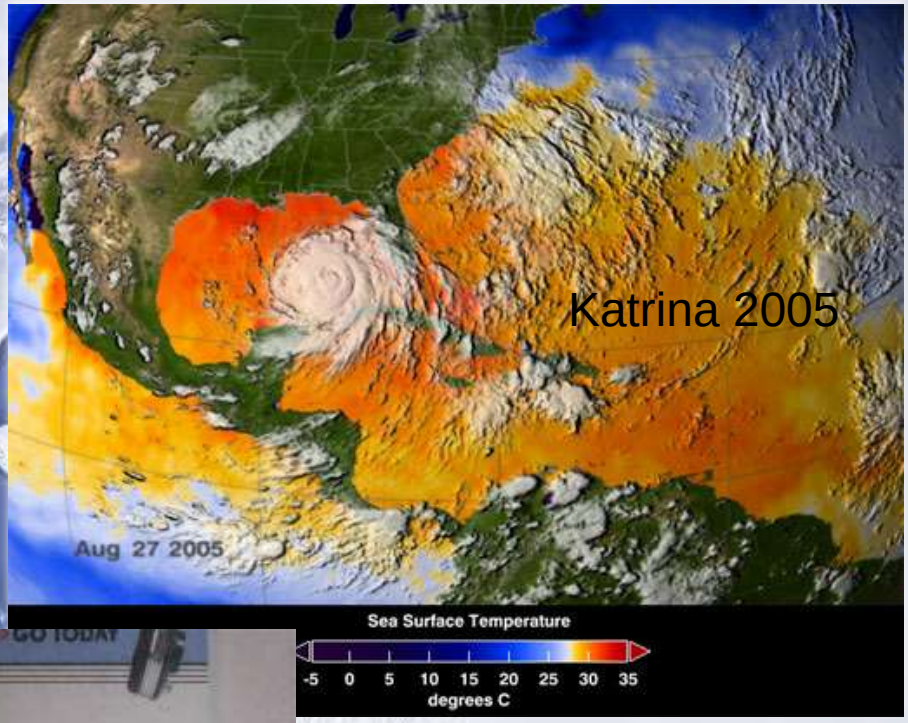


State of the Climate 2009 Highlights (NOAA 2010)

Climate Impacts

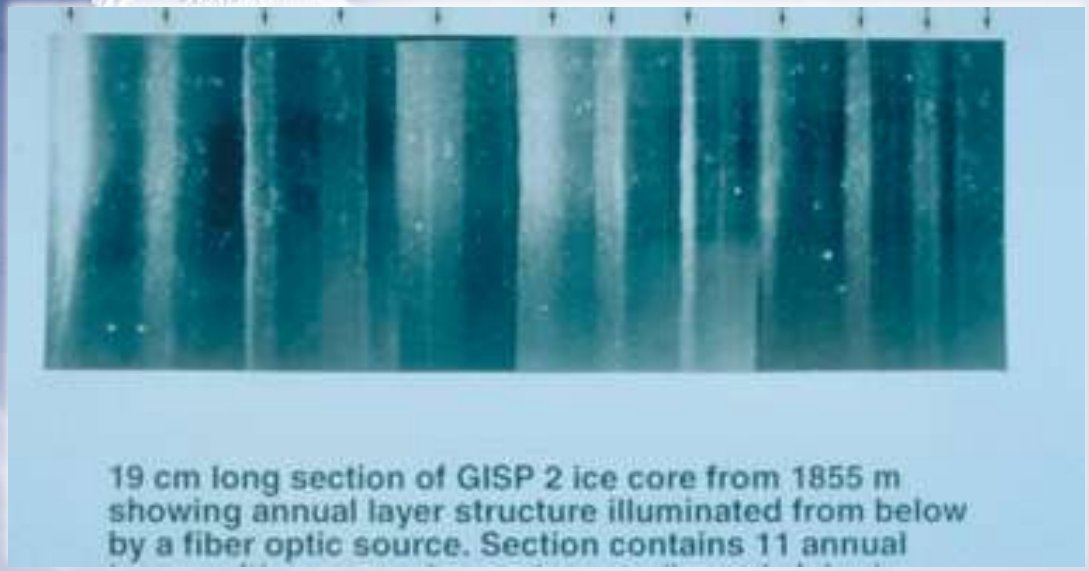


Warmer sea temperatures…

- cause stronger storms and affect atmospheric and sea circulation patterns.
- Can cause droughts in some areas and excessive rainfall in others.
- Add to the rise in sea level.
  - Warm water has a larger volume.

Past Climate: How do we know?

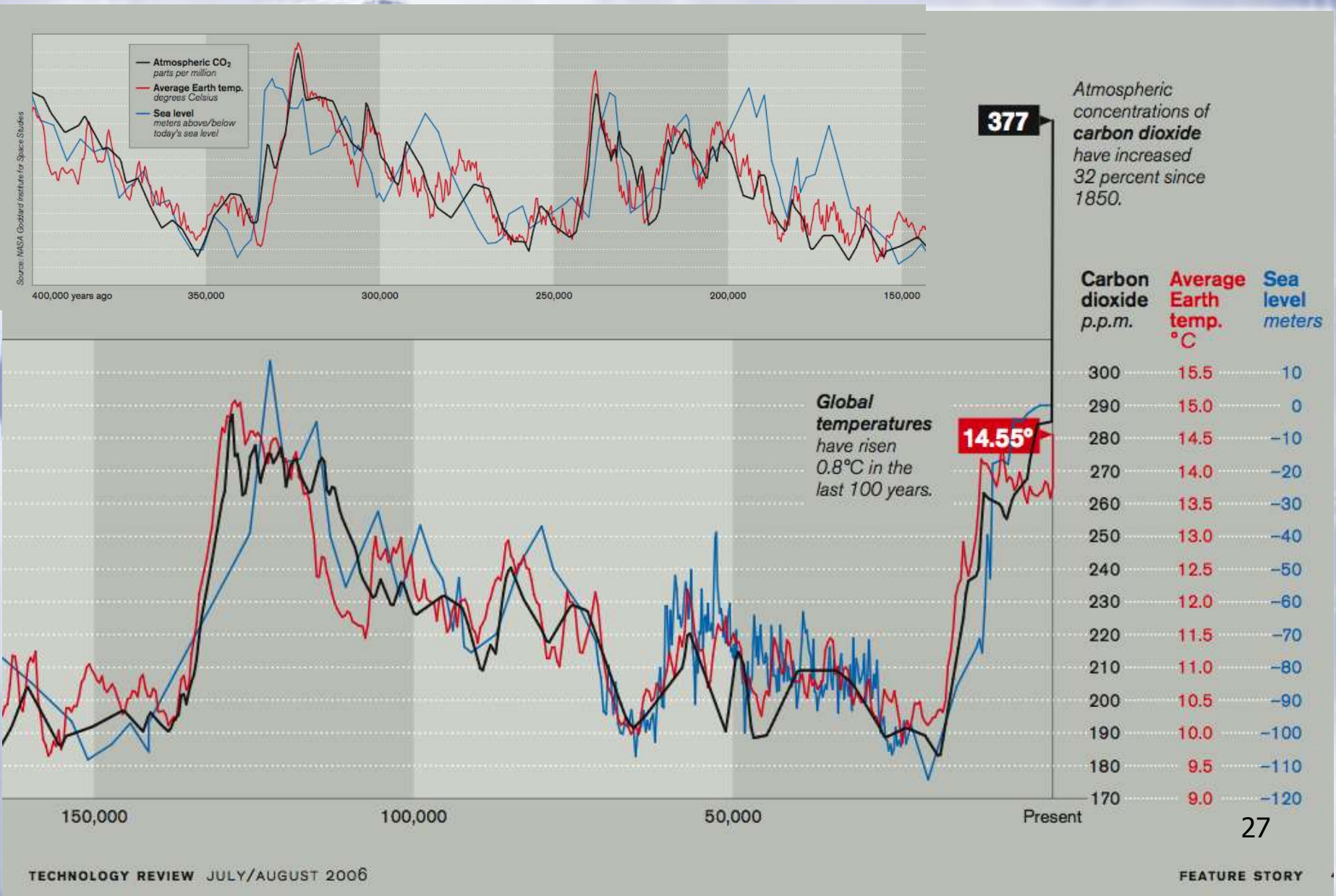
- Ice core samples: Greenland, Antarctica, etc.
- Ice traps gas bubbles, dust particles, biological material, and other materials.
- Chemical isotope ratios are proxies for Temp, CO_2 levels, etc., at various times in the past.



19 cm long section of GISP 2 ice core from 1855 m showing annual layer structure illuminated from below by a fiber optic source. Section contains 11 annual

Layers in ice core are similar to “tree rings” - showing annual cycles.

Are we responsible?



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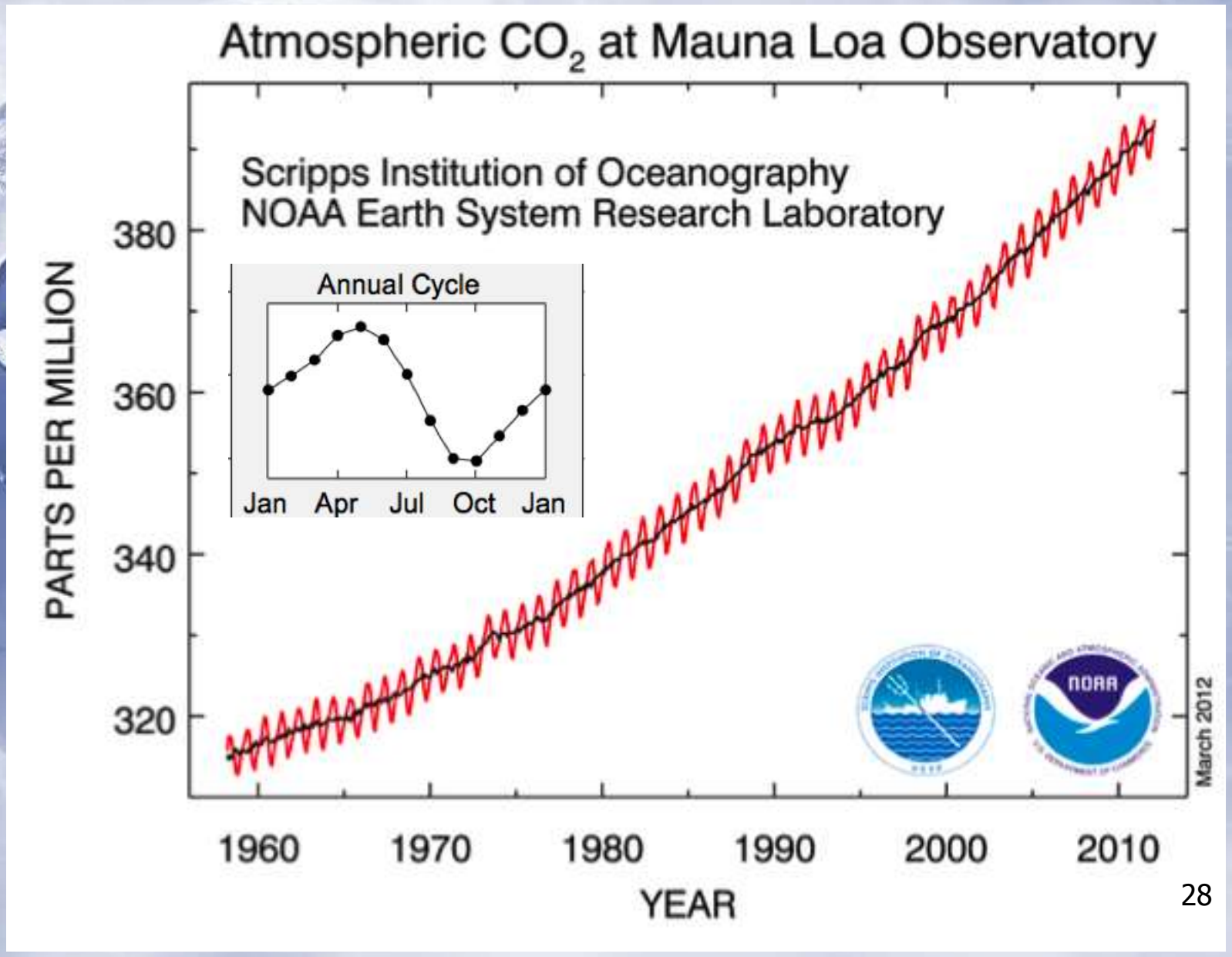

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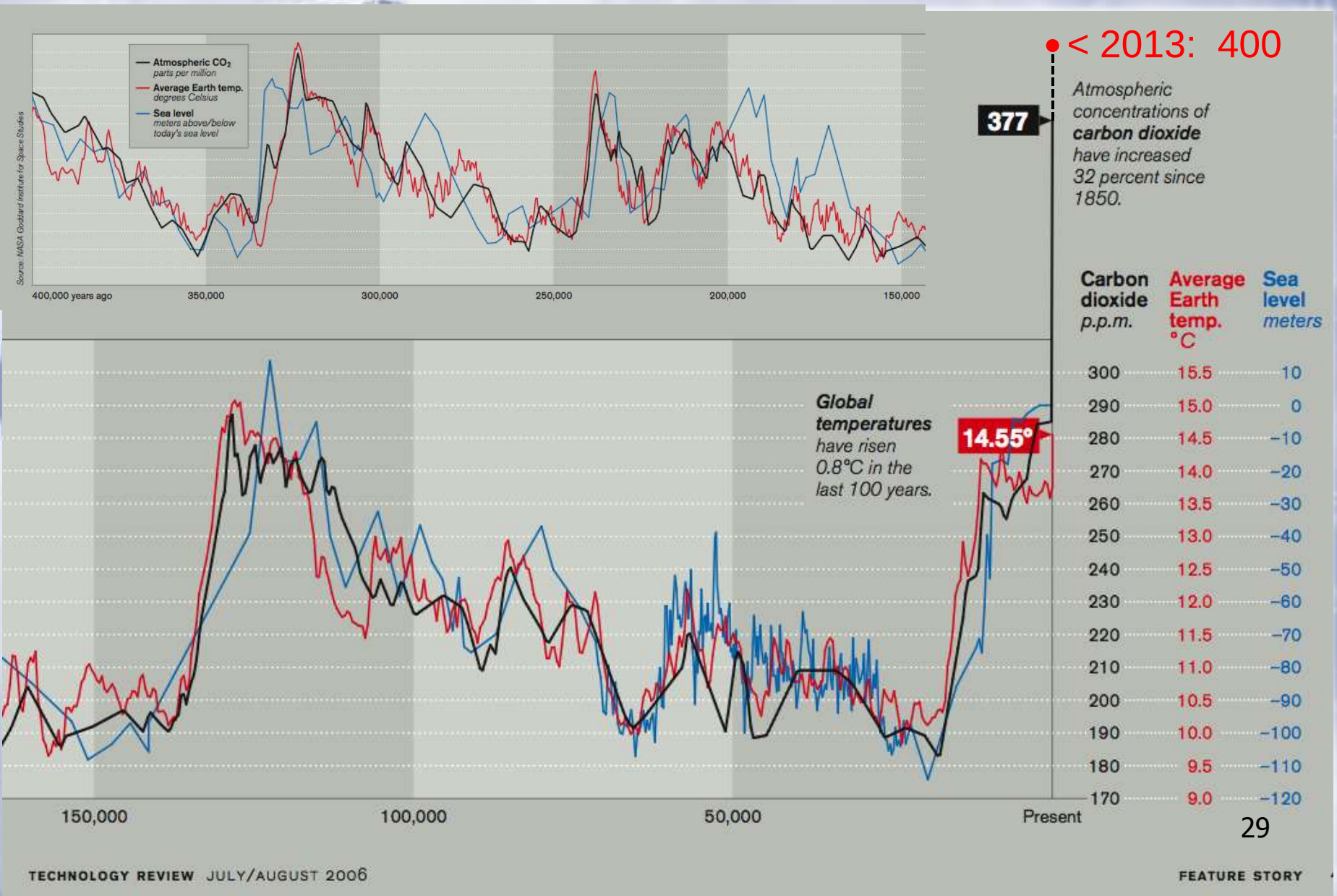
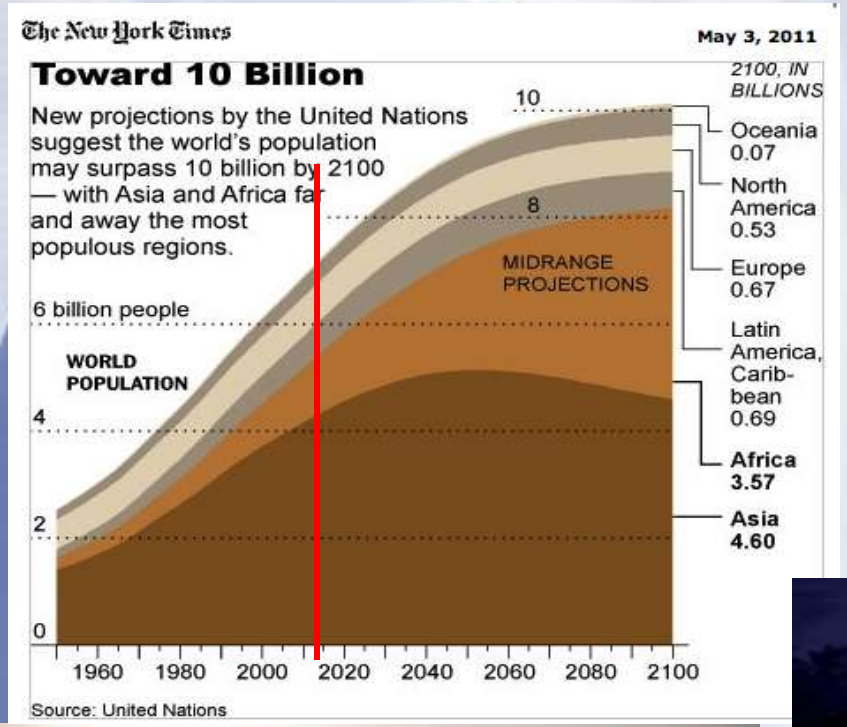
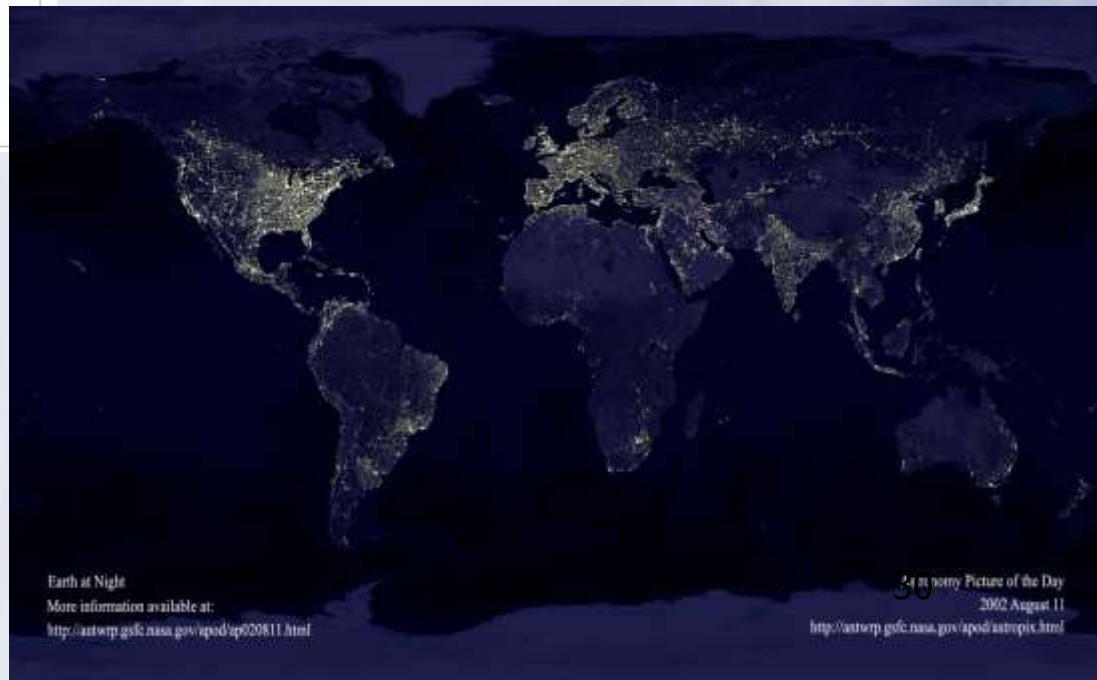


The Contemporary Challenge





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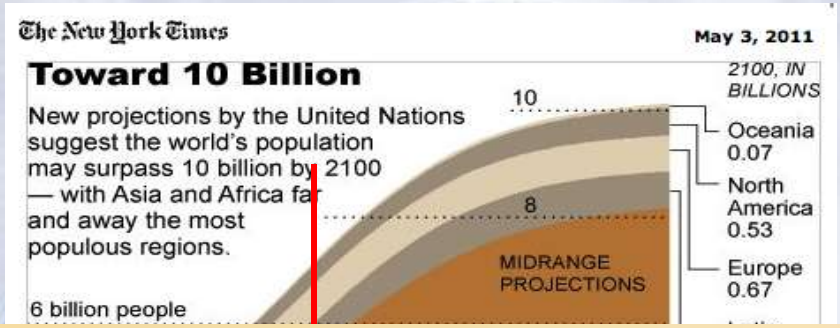


An exploding human population burning more and more fossil fuels now has a greater effect on the climate than natural mechanisms.

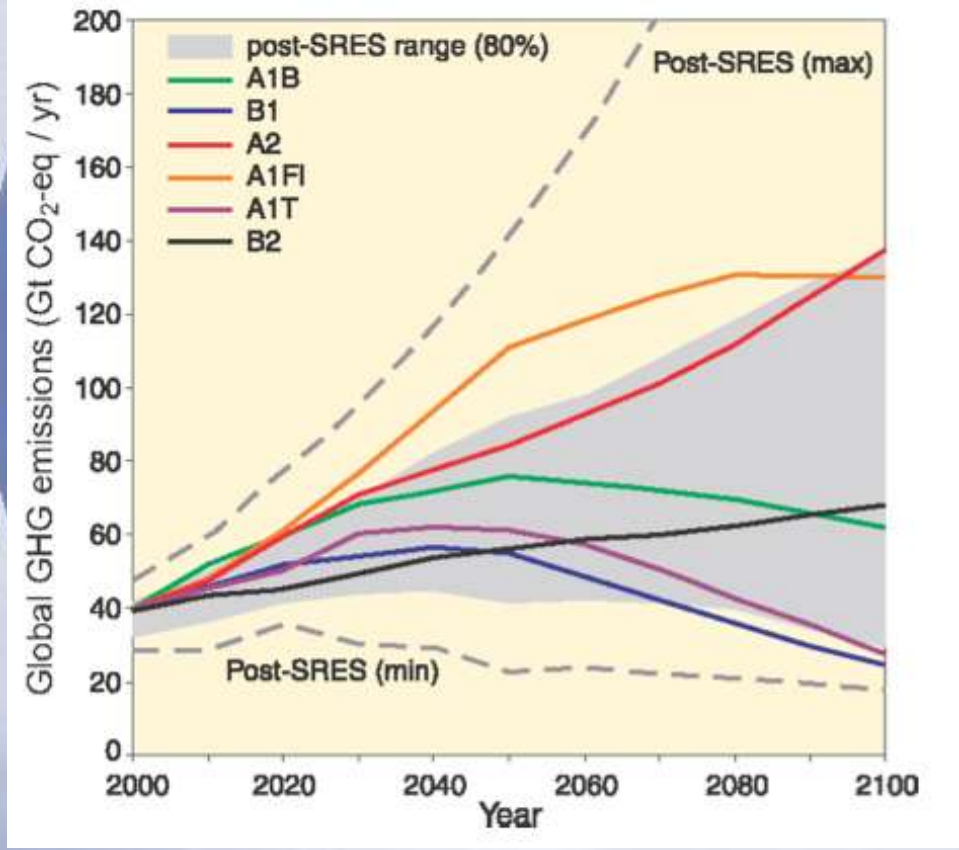
Energy (Un-)Sustainability:

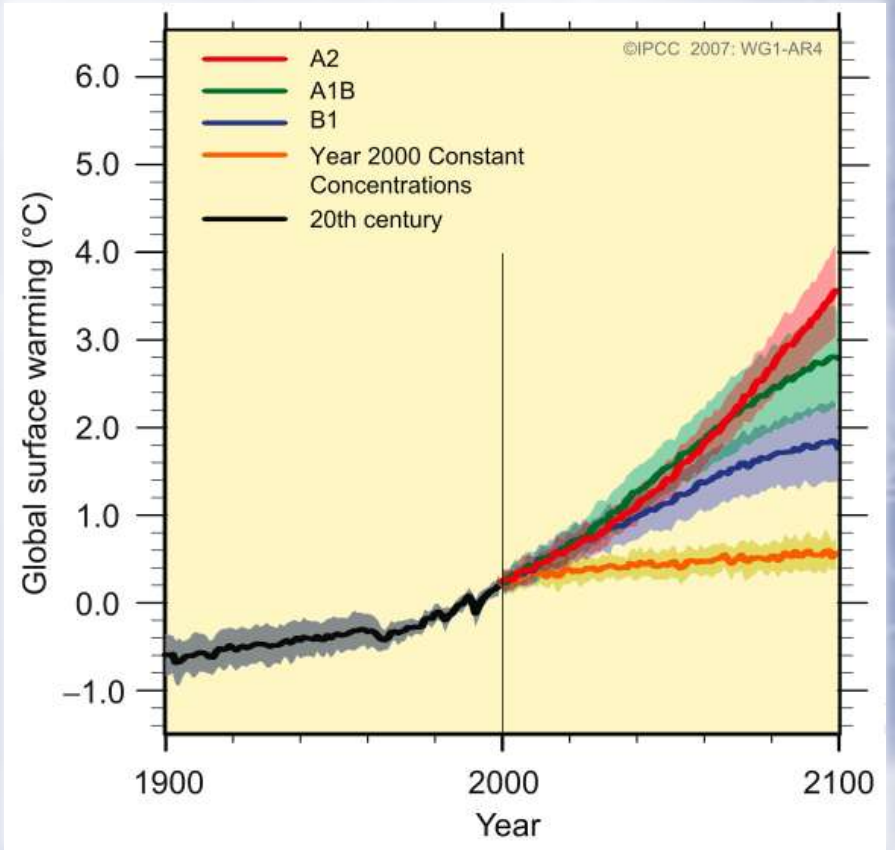
- **US per capita energy consumption** [hence, CO_2 production] is roughly **32x** that of the developing world.
  - The US consumes the energy equivalent of 10 BILLION people in the developing world!
- If the developing world rises to our level of consumption, the energy needs are *immense.*
  - If they do it with fossil fuels, ***we are toast!***
- This indicates that our level of energy consumption using fossil carbon ***is not sustainable.***

Where does it go from here?

Climate Models Provide Clues but not Definitive Answers

(because the answers depend on the assumptions one makes!)





What does the future hold?

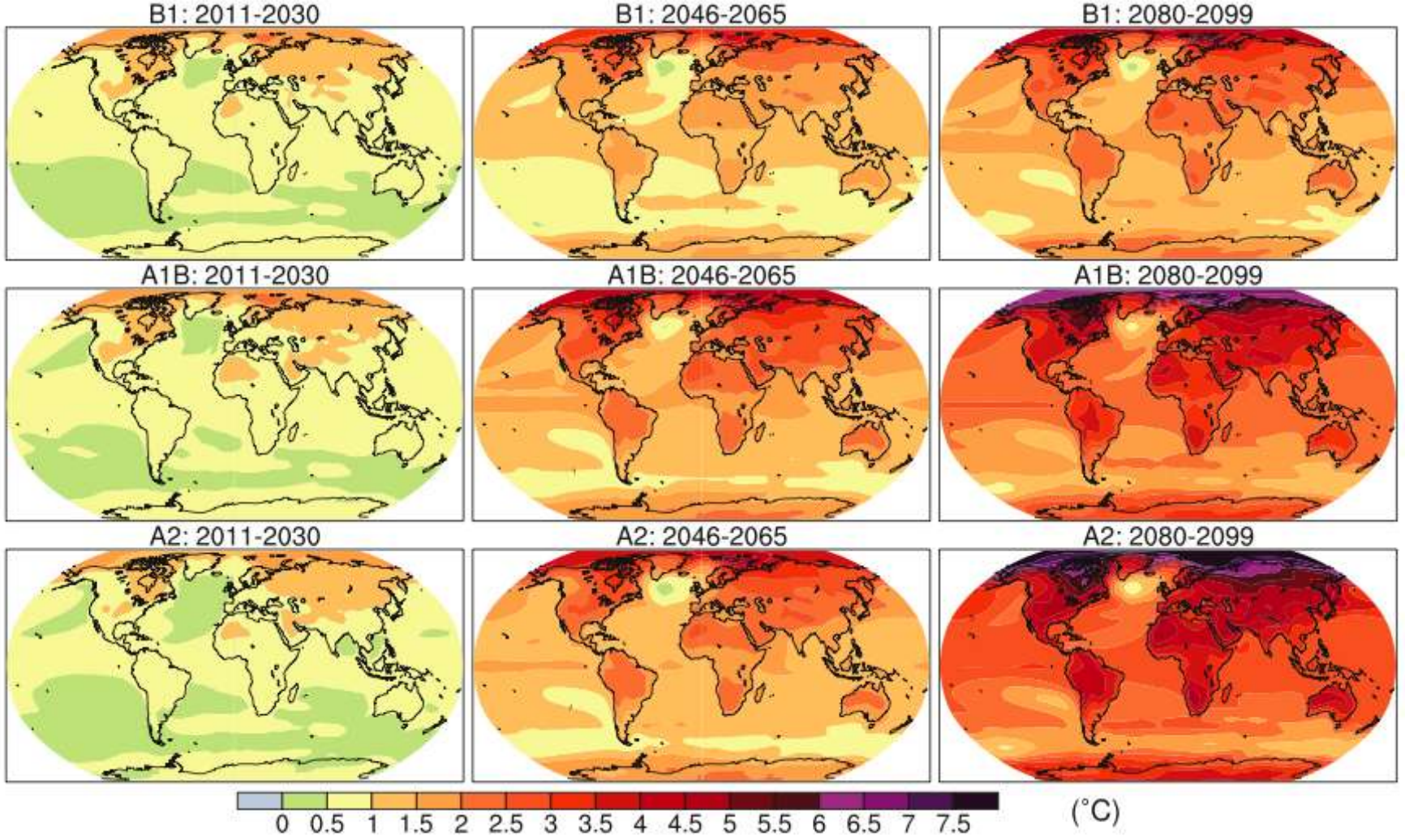
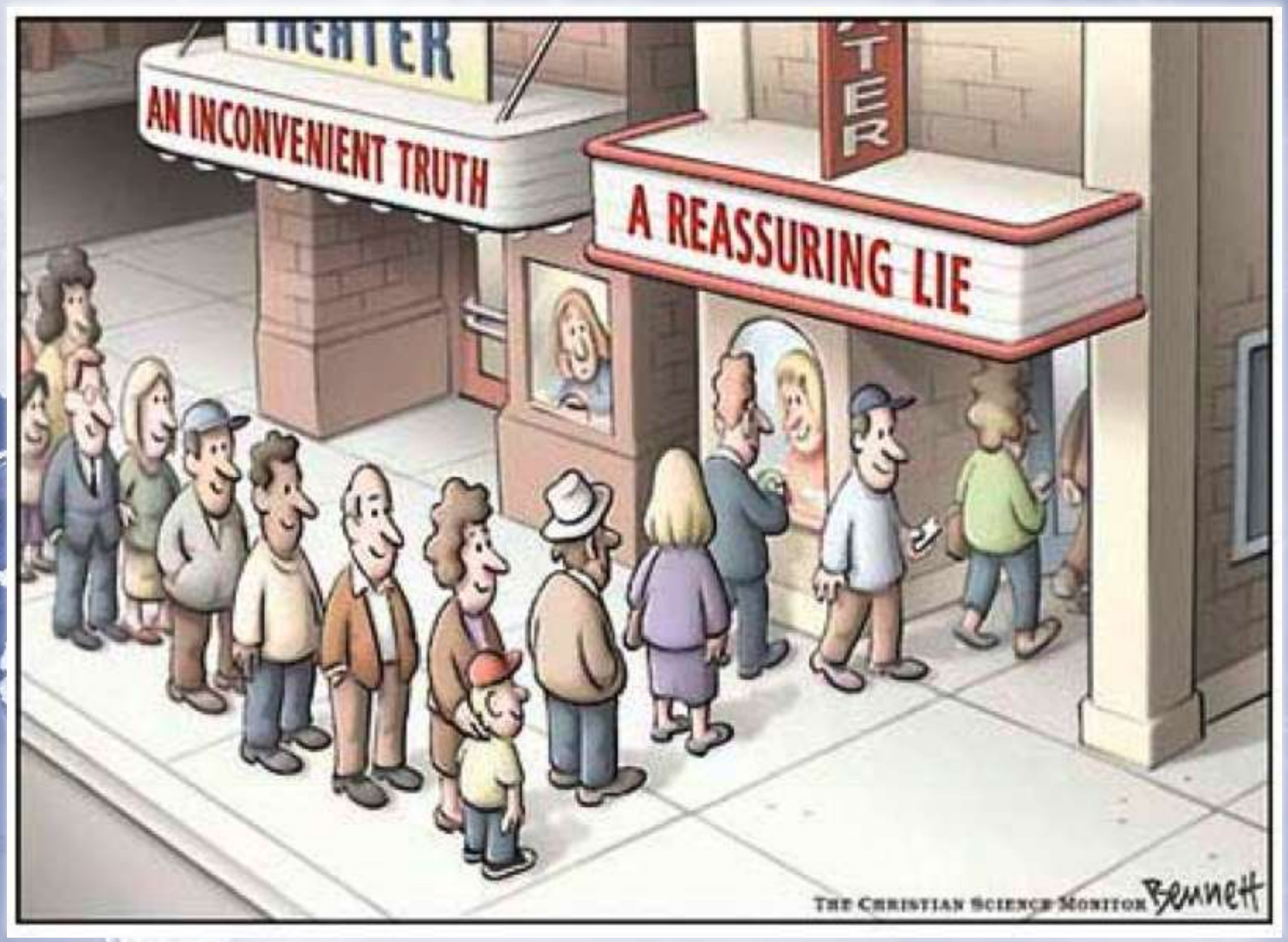
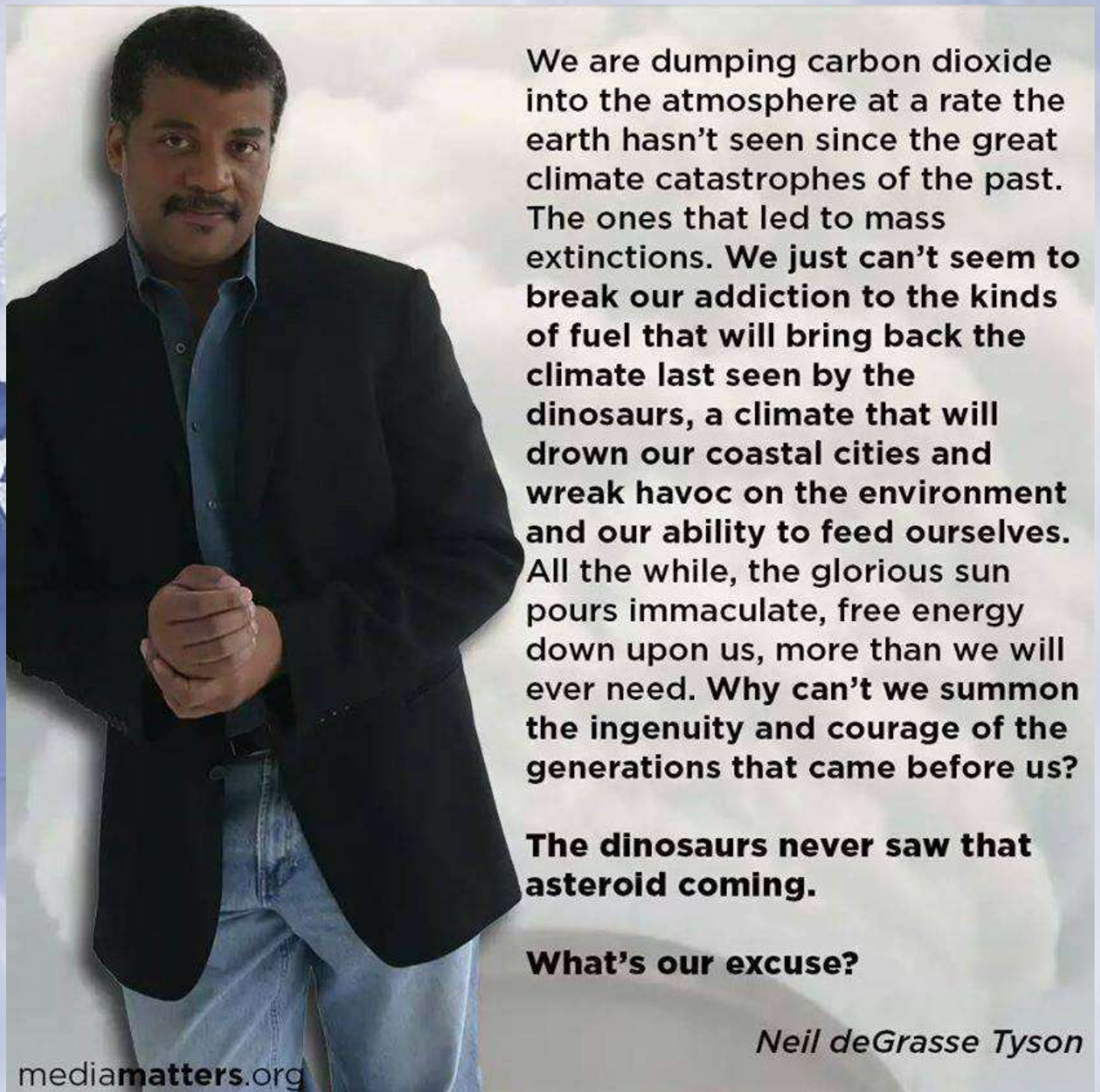


Figure 10.8. *Multi-model mean of annual mean surface warming (surface air temperature change, °C) for the scenarios B1 (top), A1B (middle) and A2 (bottom), and three time periods, 2011 to 2030 (left), 2046 to 2065 (middle) and 2080 to 2099 (right). Stippling is omitted for clarity (see text). Anomalies are relative to the average of the period 1980 to 1999. Results for individual models can be seen in the Supplementary Material for this chapter.*



We can no longer afford to ignore these truths…


We are dumping carbon dioxide into the atmosphere at a rate the earth hasn't seen since the great climate catastrophes of the past. The ones that led to mass extinctions. **We just can't seem to break our addiction to the kinds of fuel that will bring back the climate last seen by the dinosaurs, a climate that will drown our coastal cities and wreak havoc on the environment and our ability to feed ourselves.** All the while, the glorious sun pours immaculate, free energy down upon us, more than we will ever need. **Why can't we summon the ingenuity and courage of the generations that came before us?**

The dinosaurs never saw that asteroid coming.

What's our excuse?

Neil deGrasse Tyson

mediamatters.org

There are lots of reasons to get off fossil fuels, many of which have little to do with global warming…

Energy Security

Positive economic driver

Picturesque and essential. Renewable energy sources and lots of them will be essential in the coming decades

CLOSE ✕


Questions? Comments?